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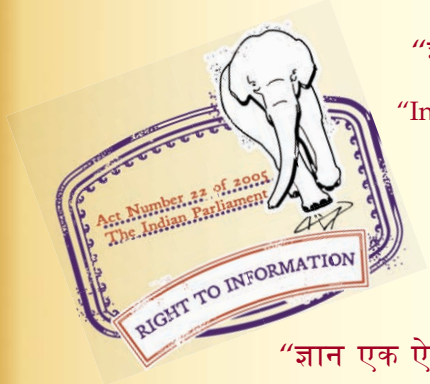

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METHOD FOR DETERMINATION OF WATER LEVEL IN A BOREHOLE

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Indian Standard

METHOD FOR DETERMINATION OF WATER LEVEL IN A BOREHOLE

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Indian Standard

METHOD FOR DETERMINATION OF WATER LEVEL IN A BOREHOLE

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 2 April 1973, after the draft finalized by the Subsurface Exploration Sectional Committee had been approved by the Civil Engineering Division Council.

0.2 The location of ground water level is an important parameter in the design of foundations of structures. Hence its correct determination is an important part of subsurface exploration.

0.3 In the formulation of this standard due weightage has been given to international co-ordination among the standards and practices prevailing in different countries in addition to relating it to the practices in the field in this country.

0.4 In reporting the result of a test or analysis made in accordance with this standard, if the final value, observed or calculated, is to be rounded off, it shall be done in accordance with IS : 2-1960*.

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1. SCOPE

1.1 This standard lays down the procedure for the determination of the water level in a borehole, cased or uncased, either during the boring operation or within a short time of the completion of the boring operation. This standard is also applicable to determining of ground water level in permanent observation holes.

1.2 This standard is not applicable for the determination of piezometric pressure changes due to a change in stress conditions of the soil or rock.

1.3 Borehole water level readings obtained by this procedure shall be supported with additional data if the water level readings are to be used to infer the elevation of the free ground water level in the vicinity of the borehole. The procedure for the determination of the ground water level by the application of the borehole water level is given in Appendix A.

*Rules for rounding off numerical values (*revised*).

1.4 This standard is not applicable for the concurrent determination of multiple water levels in a borehole.

NOTE — Multiple water levels can only be determined sequentially as the borehole progresses, with the upper aquifers completely sealed off from the borehole. Concurrent multiple water level readings can only be obtained by the insertion of an adequate number of piezometers at appropriate levels or by the installation of multiple packers isolating the different aquifers in a drill hole under the guidance of a qualified engineer or geologist.

2. DEFINITIONS

2.0 For the purpose of this standard the following definitions shall apply.

2.1 Borehole Water Level — The water level as measured at any time in a borehole.

2.2 Free Ground Water Level — The upper boundary of the saturated soil or rock at the time of measurement in an unconfined aquifer.

2.3 Piezometric Pressure — The hydraulic pressure head at a given point in the soil or rock mass in a confined aquifer.

2.4 Aquifer — A soil or rock formation that is capable of storing and yielding ground water.

3. MEASURING APPARATUS SUITABLE FOR READING WATER LEVELS

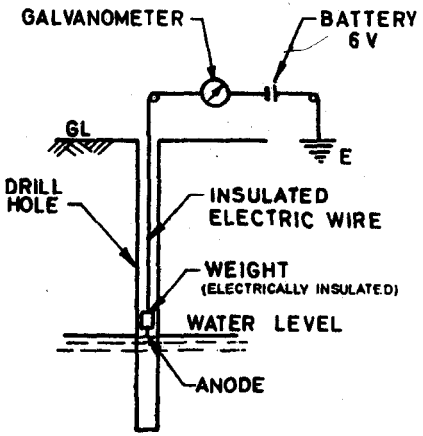
3.1 Measuring Apparatus — Measuring apparatus conforming to one of the items given in **3.1.1** to **3.1.4** shall be used for reading borehole water levels.

3.1.1 *Tape With a Weight* — A steel tape having graduation of 5 mm shall be used. For ease of measurement the tape may be chalked for a length of about one metre at the lower end. The weight shall have a volume such that it displaces a volume of water in the borehole that will not cause more than a 10-mm increase in the water level of the hole (*see* Note).

NOTE — Volumes of various sizes of holes for 10 mm depth of hole and the weight of lead weights for this volume are given below:

Hole Size, Dia	*Volume of 10 mm Depth of Hole*	*Lead Weight*
mm	cm^3	g
60	28	320
76	45	510
100	79	900
150	176	2 000

3.1.2 *Electrical Measuring Device* — Such a device as in Fig. 1 shall be equipped with a tip or probe at the end of the cable or suspending cord and the probe shall be streamlined and so designed that it shall not catch on any edge and it shall complete the circuit only when it contacts the water. The weight of the probe shall be enough to keep the cable straight, the cable shall not get stretched in length under its own weight and the weight of the probe, if the cable is directly used for measurement. The cable shall be marked with graduations similar to those on an acceptable tape or the cable/suspending cord shall be measured subsequent to withdrawal with an acceptable tape to determine the elevation of the water level in the borehole.



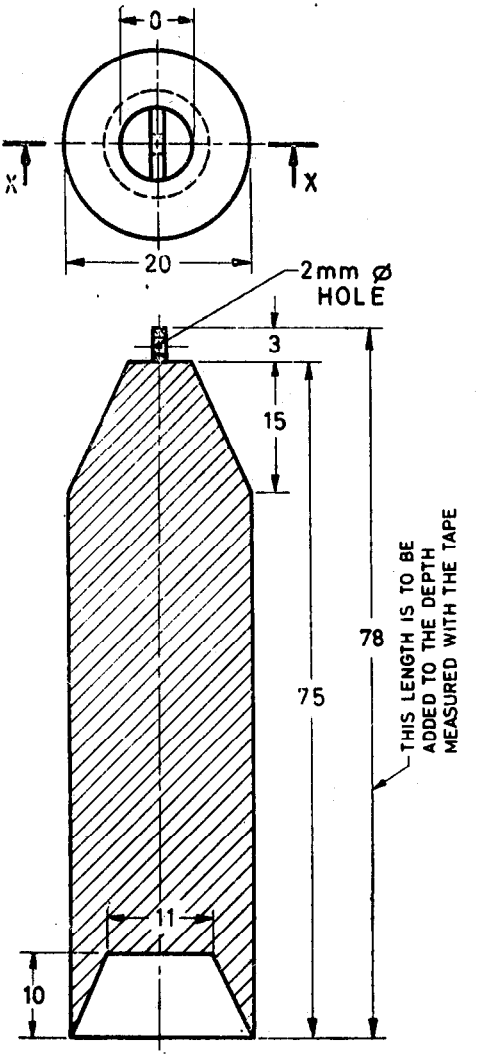
NOTE — In case of dry ground either connect the negative to casing or use two-wire circuit.

FIG. 1 DIAGRAM ILLUSTRATING USE OF ELECTRICAL EQUIPMENT FOR MEASURING GROUND WATER LEVEL

3.1.3 *Automatic Water Level Recorder* — The recorder shall be calibrated to read depth variations to the desired accuracy.

NOTE — This is used where a continuous record of the fluctuations of water level over a specified period of time has to be obtained.

3.1.4 *A Bell Sounder* — Consists of a solid brass rod about 78 mm long and diameter to suit hole, ending in a inverted cup (for typical illustration *see* Fig. 2). A steel measuring tape is attached to the upper end. The length of the sounder below the zero of the tape shall be measured carefully and added to each reading of the tape to get the true distance. The moment the cup of the sounder hits the water surface within the pipe, a distinct 'plop' will be heard.



All dimensions in millimetres.

FIG. 2 BELL SOUNDER

4. PROCEDURE FOR OBTAINING BOREHOLE WATER LEVELS

4.1 Hole Made by Wet Drilling Method — When the hole has been made by a wet drilling method ensure that the water level in the hole is the same as ground water level by depressing the water level by evacuating with compressed air or with a sand shell. After this operation is completed take 3 (more if required) water level readings at 10 to 15 min intervals if the last two consecutive readings do not differ by more than 5 cm, the corresponding lower water level should be taken as the ground water level (*see* Appendix A).

4.2 Hole Made Using Drilling Mud — When drilling mud has been used thoroughly flush and wash the hole with clean water. Then determine the ground water level as in **4.1** (*see* Appendix A).

4.3 Hole Made by Dry Drilling Method — When the hole is bored by dry drilling method, determine the ground water level as soon as it is inferred that the ground water level has been reached, without advancing the hole further. Take a series of 3 (or more if required) readings at approximately equal intervals with a minimum of 5 min elapsed time between readings. In an exceptionally previous strata the interval may be reduced to as low as one minute (*see* Appendix A).

4.4 Other Requirements for All Water Level Determinations

4.4.1 Ensure that all surface seepage water has been sealed off from flowing into the borehole.

4.4.2 In case the subsoil strata in the vicinity of the water table in a borehole consists of loose cohesionless material or other material which may lead to caving of hole due to fluctuation of water level or due to flushing and washing with clean water, case the hole beforehand in order to prevent the water level in the hole being vitiated by possible collapse of the hole. In case of permanent water level observation wells the casing shall be blank up to ground water table and of perforated pipe below. If casing is used to seal off seepage water or to prevent the hole from caving, then the hole shall be extended below the casing 1 to 2 casing diameters, and preferably not more than 10 to 15 cm.

4.4.3 Record the date, the time and the elevation of all the water level readings taken.

4.4.4 Cap hole between readings if readings are to be taken over an extended period of time.

5. DATA TO BE RECORDED

5.1 The following data shall be recorded for each series of borehole water level reading taken:

a) Datum of reference point from which measurements were taken, and

b) Log of borehole (*see* IS : 4464-1967*).

5.2 When required the following data may also be recorded:

a) Time that has elapsed since last change in the water level in the borehole,

b) Depth of water column above bottom of the borehole and the length of casing in the borehole,

c) Atmospheric pressure at the time water level was taken,

d) Fluctuation in water levels of nearby bodies of water which may affect water level readings in the borehole and recording time and magnitude of this fluctuation, and

e) Distance to closest adjacent borehole if the adjacent hole might have some effect on the borehole water level.

APPENDIX A

(*Clauses* 1.3, 4.1, 4.2 *and* 4.3)

DETERMINING THE GROUND WATER LEVEL BY THE APPLICATION OF BOREHOLE WATER LEVEL

A-1. APPLICABILITY OF BOREHOLE WATER LEVEL

A-1.1 Borehole water levels taken while water is being circulated to advance the borehole will bear no relation to the ground water level unless sufficient time is allowed for the borehole water level to stabilize near the ground water level.

A-1.2 Boreholes drilled by dry methods may have advanced below the ground water table before water is noticed in a borehole. A borehole water level reading taken before the water level has had time to stabilize will not correctly represent the ground water level.

A-1.3 In many areas more than one ground water level may be found due to an impervious material lying between two aquifers and effectively separating them. A borehole penetrating the impervious layer then becomes a channel for water to flow from one aquifer to the other and the borehole water level will stabilize at some elevation between the ground water elevations in the two aquifers.

A-1.4 Drilling mud used in a borehole can effectively seal off pervious formations preventing the fluid in the borehole to drop to the existing ground water level or *vice versa*.

*Code of practice for presentation of drilling information and core description in foundation investigation.

A-1.5 The time required for a borehole water level to stabilize at or near the ground water level depends upon the permeability of the formation and the initial head differential between the borehole water level and the ground water level. Typical times required for 90 percent of this initial gap between the water levels to close when soil is flush with the bottom of the casing are given below:

a) Medium and coarse sand	1 to 6 min
b) Fine sand	About 1 h
c) Medium and coarse silt (*see* Note 1)	½ to 4 days
d) Fine silt (*see* Note 1)	Up to 42 days
e) Clay (*see* Note 1)	Not practical to determine free ground water level from boreholes unless material is fissured.

NOTE 1 — The above limits are meant as a guide. While dealing with these formations porous tube piezometers will be found more suitable for observation of ground water level. For details of these piezometers reference may be made to the draft 'Indian Standard code of practice for installation, maintenance and observation of instruments in earth dams: Porous tube (Casagrande type) piezometers.' (*under preparation*) (*see* Note 2).

NOTE 2 — Until this standard is published, the matter shall be subject to agreement between the concerned parties.

A-1.5.1 If the hole is extended about 3 diameters below the bottom of the casing, the increased intake area will reduce the time required to about 25 percent of the values given in **A-1.5**.

A-2. INTERPRETATION OF BOREHOLE WATER LEVEL

A-2.1 If free communication has been established with the formation, and there is no seepage into the borehole from overlying formations the stabilized borehole water level will be closely equivalent to the ground water level in the formation.

A-2.2 For artesian conditions where the formation is overlain by an impervious layer the stabilized borehole water level will be equivalent to the pressure head in the formation.

A-2.3 If insufficient time is spent waiting for the borehole water level to stabilize, the inferred position of the ground water level may be calculated from the following equation if three borehole water level readings are taken at suitable equal time intervals:

$$h_0 = \frac{h_1^2}{h_1 - h_2}$$

where

h_0 = the distance the borehole water level shall change in order to be closely equivalent to the ground water level,

h_1 = the distance the borehole water level changed during the time interval between the first two borehole water level readings, and

h_2 = the distance the borehole water level changed during the time interval between the second and the third borehole water level readings.

NOTE — The formula in **A-2.3** is based on the theory of hydrostatic time lag.

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